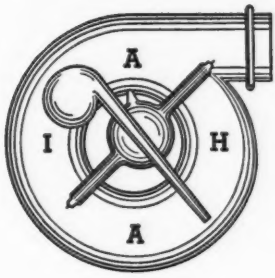
AMERICAN

INDUSTRIAL HYGIENE

ASSOCIATION

QUARTERLY



VOLUME 7 SEPTEMBER, 1946 NUMBER 3

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Volume 7 SEPTEMBER, 1946 Number 3

This Issue

Members and non-members of the A.I.H.A. who desire to present papers at the Annual Meeting at Buffalo, April 27-May 3, 1946, are requested to send the titles of the papers, together with a brief description of the subject matter, to Col. T. F. Hatch, Industrial Hygiene Foundation, 4400 Fifth Avenue, Pittsburgh, 13.

THAT the General Motors Corporation is well equipped to provide industrial hygiene services throughout its many plants is obvious on perusal of the paper by FRANK A. PATTY, President of the A.I.H.A. and Head of the G.M.C. Industrial Hygiene Department. . . . IT IS hoped that significant data on effectiveness of bactericidal aerasols may soon be forthcoming on use under controlled conditions of dispersion equipment described by DRS. PUCK and CHANEY. . . . IT IS an encouraging note that a vice-president in charge of purchases of a large corporation has actually set in motion such a complete yet practical system for checking on potentially hazardous materials brought into the plant as that outlined by ANDREW H. PHELPS. . . . OF MUCH interest to the chemists is a discussion of the applicability of the polarograph to industrial hygiene problems by F. H. GOLDMAN and IRVING MAY of the U. S. Public Health Service. . . . THE effective exhaust ventilation for a machine particularly difficult to enclose, as described by E. D. SALLEE and R. B. CARTER serves as an excellent example of what can be done when determined inginuity of a well-trained team goes to work on a problem.

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Volume 7 SEPTEMBER, 1946 Number 3

General Motors Industrial Hygiene Service

FRANK A. PATTY,
President, American Industrial Hygiene Association,
Head, Industrial Hygiene Department,
General Motors Corporation,
Detroit, Michigan

BEFORE discussing something of what General Motors is doing and hopes to do in industrial hygiene, perhaps I should define "industrial hygiene" because the term has no generally accepted definition. Webster defines hygiene as the science of the preservation of health. Industrial hygiene has been defined as the science and art of recognizing, evaluating, and controlling the causes and sources of diseases occurring characteristically in industry, and of preserving the health and well-being of those engaged in industry. A somewhat simpler definition has also been suggested: the science and art of recognizing, evaluating, and controlling potentially harmful factors in the industrial environment.

Industrial hygiene is not a new science or art but one that has been recognized and, to some extent, practiced from the time of Pliny down through the ages. It is the present concept of industrial hygiene which is relatively new—the concept of anticipating and recognizing potentially harmful situations and applying engineering control measures before serious injury results. There are some who question industry's ability to control all harmful exposures and there is quite naturally a tendency to take the easy way out of a difficulty by substituting materials of low or moderate toxicity for those of a hazardous nature. Nevertheless, where incentives such as low cost, availability, or superior properties of a hazardous material justify the provision of positive engineering controls, they can be supplied promptly.

Some say artists are born, but there can be no doubt that industrial hygienists must be made, and it takes years to mellow some of us with sufficient understanding that we can use our knowledge of the basic principles of industrial hygiene to the best advantage in accomplishing our goal.

Looking back over 18 years in this work —first, in a U. S. Government Bureau, second in the employ of an insurance company, and now in the service of a large industry—I realize that my outlook has changed as a result of experiences along the way.

Depending somewhat upon where we acquire our academic training and initial experience in field work, especially if we are associated with an official agency, we are likely to start out with the idea that industry has one purpose—to make money—and that, in following that urge, the humanitarian aspects are apt to be neglected. Our first ideas of introducing hygiene to industry are likely to involve some means of maneuvering into a position where our recommendations for control measures are to be accepted as commandments not to be questioned and not, upon penalty of closing up shop, to be ignored. It is only gradually that we become aware of the fact that in promoting anything to the American public a sound idea "takes" more quickly and develops faster if it is "sold" rather than

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presented as an ultimatum. As a people we basically resent being told bluntly that we have to do a thing: we much prefer to "discover" for ourselves that the proposed new course is correct and therefore to our advantage. James Truslow Adams expresses these ideas well in his recent book, Big Business in a Democracy, from which I quote, "The American is a composite of almost all races, nationalities, and classes. He hates a bit and bridle as heartily as does a young colt. . . . There *are* dirty politicians, dirty labor leaders, dirty business men, black markets, some selfish and dirty consumers; but the Americans, now 138,000,000 of them, *the American people,* are the hope of the world and of the whole *future* of humanity." It is with somewhat of a shock that some of us learn that many industries are eagerly taking the initiative in bettering the working environment of their employees.

The industrial hygienist becomes aware that salesmanship is a necessary part of his practice. The salesman will think of the "buyer's" point of view and first of all develop his recommendations for environmental controls with the understanding of an economist, and then stress all of their advantages. He will simplify his work by taking advantage of the viewpoint of production engineers and occasionally going them one better by saving them money in the conservation of materials or recovery of a by-product. One cardinal rule he learns early is not to "bluff" or try to impress his audience with his superior knowledge. Some few persons have the ability to "get away with it" but the odds are against us and it's much safer to get on the same plane with our audience, whether that means a step down or a jump up, and it helps to imagine ourselves in the position of the man we are trying to influence.

It would be a mistake to attempt to give the impression that industrial hygiene is pure science; or that it is restricted to the art of applying scientific principles. Much of it involves a liberal use of common sense or what is perhaps better known as "horse sense." The job will never become monotonous or routine because the chemist, the physicist and the engineer will keep introducing new more or less hazardous materials and processes that require new developments for the evaluation and control of exposures attendant to their use. Neither is the job glamorous or spectacular: much of it is hard work bordering on drudgery, but it has its compensations.

But, to get back to General Motors and how we operate our Industrial Hygiene Department; first of all, it is necessary to understand that General Motors operates as a decentralized system in which each of its scores of Divisions has autonomous power and, although there are certain corporation policies that are adhered to, each plant manager rules supreme in his own domain.

The General Motors Industrial Hygiene Service had its beginning in 1936 when it was organized by DR. C. D. SELBY as a part of the health maintenance program. Because of the availability of personnel and equipment, it was operated as a part of the Chemistry Department of the Research Laboratories Division in Detroit; it also operated for a time under the Electro-Chemistry Department. In 1945 it was accorded departmental status and is now called the Industrial Hygiene Department, still located in the Research Laboratories Division and still under the general direction of General Motors Personnel Staff and DR. SELBY, head of the Corporation's Health Maintenance Staff.

Our own industrial hygiene staff includes a ventilation engineer, two analytical chemists, three chemical engineers, and a stenographer-secretary besides myself. The service which we offer is available to managers, personnel directors, medical directors, safety directors, and industrial hygienists, as well as responsible production and maintenance engineers of all our Divisions. Contacts are made by the Divisions through the Central Office Personnel Staff, through DR. SELBY or his associate, DR. LUTZ, or directly to the Industrial Hygiene Department, depending upon circumstances and previous associations.

We make no attempt to conduct all of the corporation's industrial hygiene activities from the central office. On the contrary, we foster and encourage Divisional activities and some of our Divisions have industrial hygiene laboratories staffed by very capable full-time industrial hygienists. For the most part, however, our Divisions, engaged in what amounts to machine shop processes, do not have sufficient industrial

hygiene work to keep a man busy as a full-time project. In such an instance we encourage the Division to pick out one or more men with suitable chemical or engineering backgrounds and teach them the fundamentals necessary for them to conduct the work that is required to be done. This man frequently is a chemist, though he may be a mechanical engineer, or a technically trained safety engineer. Frequently, the work is divided between a man on the plant engineering staff who is responsible for the plant ventilation and a chemist who does the sampling and analysis and who works closely with the medical director. If we place an industrial hygienist on such a job it necessarily must be someone who is qualified and willing to spend part of his time at other duties.

All medical directors with General Motors are aware of the value of industrial hygiene in helping them maintain employee health. Several of them are so much interested in this work that they make their own periodic inspection tours often in company with the safety engineer, and are intimately versed on any plant processes involving exposures potentially harmful to health. It is the General Motors policy to teach physicians entering industrial medicine how they can profitably make use of industrial hygiene, but not how to be industrial hygienists. In order to use anything intelligently it is necessary to understand something of how it works, and to that end an orientation course in industrial hygiene is planned for prospective plant physicians.

Some of the Divisions, especially in the Detroit area, lean heavily upon the industrial hygiene service provided by the Central Office, which is furnished as a corporation expense without charge to all Divisions.

Regardless of whether industrial hygiene service is provided within a Division, we make periodic visits to all plants for preliminary surveys or inspection surveys. Whenever we visit a plant we make it a point to get one or more persons to accompany us who are familiar with, and interested in, industrial hygiene problems, and who at the same time have or can readily obtain intimate details of plant processes. These men may include the medical director, the safety engineer, a production engineer, a chemist, or other persons. The person who acts as a guide for industrial hygiene inspection surveys can make the visit profitable or difficult, and the extent of his help will depend not only on his knowledge of plant processes but also upon the surveyor's ability to reach a common understanding with him regarding points of interest. This preliminary survey may be followed by a report on any questionable practices along with suggested corrective or control measures. It may also be followed up with analytical or other tests to evaluate more obscure environmental conditions if this seems to be warranted.

Nature of General Motors Industrial Hygiene Service

FUNCTIONS: The primary purpose of the Industrial Hygiene Department is the study and control of environmental conditions as they may affect the health of General Motors employees. Its studies also include the prevention of fires and explosions resulting from inflammable vapors, gases, or dusts; the control of corrosion or abrasion caused by air contaminants; and the prevention of neighborhood nuisances from atmospheric pollution. It also acts as a clearing house for health-protection ideas, suggestions on employee health protection are invited from all Divisions for general distribution.

SERVICES OFFERED: A general list of the services of the Department follows, with brief individual explanatory notes on each service.

1. CHEMICAL EVALUATION OF THE ENVIRONMENT: This service consists of sampling and analyzing the kind and amount of atmospheric contamination such as gases, vapors, mists, fumes, or dust. For routine environmental control work we prefer analytical methods that give results in the field over methods requiring laboratory evaluation. Where the purpose of a survey is only to develop satisfactory control measures we may do very little analytical testing. An experienced man with nothing more than his five senses and a smoke tube can develop and apply a great deal of useful information for process controls. Working environments are sampled, however, to establish whether conditions are satisfactory and whether control measures are necessary.

Such tests may also be desired as a result of employee complaints or to supply information to support or refute the necessity for control measures recommended by an official agency. I want to make it clear, however, that counteracting health control recommendations is neither our purpose nor our interest. We have the best of relations with all state, city, and national industrial hygiene departments. Many of them submit copies of their reports of surveys of our divisions directly to us and we welcome this cooperation. We always encourage prompt compliance with any and all logical recommendations.

On the other hand, there have been a few isolated instances when we have been called in by a Division to make a check determination to find out if certain official recommendations, involving considerable expense, were necessary and justifiable and, in the few instances where we have been unable to support the official findings, we have succeeded in having the situation considered further to the eventual satisfaction of all concerned.

Periodic records of analyses of environmental conditions are valuable in the event of claims of injury due to past occupational exposure.

Study is made and advice given regarding the probable and possible effects of a recognized air pollution.

2. PHYSICAL EVALUATION OF THE ENVIRONMENT: (a) *Radioactivity:* Exposures to x-rays, gamma rays, and radioactive materials, as in some luminous paints, are measured and evaluated. (b) *Other radiant energy:* Infra-red and ultra-violet rays are measured and evaluated. (c) *Lighting:* General plant lighting and job lighting are compared with accepted lighting practices and effective lighting systems in use in other Divisions. (d) *Noise:* The loudness of noise is measured in decibels, frequencies are analyzed, and advice is given regarding probable effects upon employees. (e) *Temperature and Humidity:* Abnormal temperatures and humidities are studied with a view toward correction.

3. CONTROL MEASURES: Whenever any questionable or unfavorable environmental condition is found as a result of our surveys or is reported by a Division, we offer suggestions or recommendations for a method or alternative methods of control.

4. ANALYSIS OF MATERIALS: (a) Biological specimens are analyzed for possible toxic materials. Many urine specimens from persons with potential exposures to lead or fluorides are analyzed to determine the over-all exposure of individuals. This method may be used instead of air analyses, or to supplement air analyses in the evaluating of plant exposures. (b) Raw materials, intermediates, by-products or products are analyzed, when necessary, to determine their hazardous or potentially hazardous nature. Solvents of unknown composition are always under suspicion when used in open containers or dispersed in workroom atmospheres.

5. DERMATITIS: Minor or obvious causes of dermatitis are pointed out and corrective measures suggested. The Central Office Health Maintenance Staff and the Industrial Hygiene Department are prepared to make joint studies, in collaboration with Division Medical Departments, concerning Division dermatitis problems. Studies of this nature in the past have been helpful in determining the cause or causes of cases of dermatitis and in establishing satisfactory controls.

6. VENTILATION: Our ventilation service includes consultation with the Divisional ventilating engineer or ventilating contractor regarding air volume or velocity; air cleaning; hood or booth design and location; make-up air; and other factors pertaining to process or general ventilation, for health and comfort. Efficiency tests are made on air cleaners such as air washers, filters, precipitators, and cyclones. Particular attention is paid to situations where the air is recirculated, or where recirculation of air would be desirable. The Industrial Hygiene Department reviews plans for proposed ventilation of present buildings, or for new construction. Opinions are rendered as to the efficiency and suitability of planned ventilation and suggestions are given regarding improvements or changes.

7. RESPIRATORY PROTECTIVE APPARATUS: All respirators are considered a temporary expedient, and their continuous use is discouraged except in unusual circumstances. The Industrial Hygiene Department makes atmospheric pollution studies and submits recommendations on personal respiratory protection. These studies include careful observation of the operation, the use of

any respiratory protection equipment, and recommendations based upon findings.

8. SANITATION: We do not stress sanitation as a part of our service but do point out, with control suggestions, any rather obvious departures from generally accepted practices in sanitation, including plumbing cross connections. It may be appropriate to mention here the desirability of encouraging workmen to eat lunches only in uncontaminated surroundings. It is General Motors practice to provide cafeterias and lunch rooms in their various plants so that eating in workrooms does not present a problem.

9. PERSONNEL SERVICE: The Industrial Hygiene Department is in a particularly advantageous position to assist the Divisions in selecting personnel for industrial hygiene work. Requests for personnel are given consideration and attention, aimed at securing the best and highest type applicants for each particular job.

Division industrial hygiene departments are invited to participate and to make full use of these services at all times. Close cooperation between departments and the exchange of ideas and methods go far in helping to solve the increasingly important problem of providing and maintaining healthful working conditions. It also helps to eliminate costly errors in industrial hygiene control which are likely to occur when a new method or process is installed. Pooled knowledge and experience eliminate much wasted time, effort, and material, and assure the latest and best procedures.

The General Motors Industrial Hygiene service is available to responsible persons in our Divisions and may be obtained without charge through the General Motors Personnel Staff, the Health Maintenance Staff, or directly from the Industrial Hygiene Department.

Reports of Surveys

ALL OF our surveys are followed by written reports of all tests made, accompanied by suggestions or recommendations for the control of any questionable or unsatisfactory conditions found. We mimeograph these reports so that each interested and responsible person may have a copy.

The question arises as to who these people are. We have no fixed pattern in this respect and it varies with each Division, but certainly the medical director, who is responsible for the health of the employees, should have a copy of all such survey reports. Likewise it is just as important that the safety engineer be appraised of any conditions involving safety, and in many plants the safety engineer can correct environmental conditions by employee education through the foreman. Where the report involves process or construction engineering matters, it is essential that the entire report reach the production supervisor and any process or maintenance engineers involved. Obviously the personnel director is interested, and so is the Division manager. There is no uniform pattern regarding the Division representative to whom reports are sent for distribution, but usually it is the manager, the personnel director, or the medical director.

In the performance of our tasks, we have numerous opportunities for liaison, and fostering of good relations between the medical director and the safety director in the plant; that is an easy matter within our organization because all of us work under the personnel staff.

The safety engineer may regard the prevention of fires and explosions from vapors, gases, mists, and dusts or the designation of personal respiratory protection devices as within his field of activity, but, unless he is exceptionally well qualified, he will need and appreciate the industrial hygienist's help in these matters. The industrial physician, with no engineering experience is primarily concerned with the toxicological aspects of the problem and, in his desire to prevent harmful exposures, may consider only the promotion of health without due regard for practical economic measures or the problems of plant production and maintenance engineers. It is part of the industrial hygienist's job to develop the physician's interest in plant operations and help him to become process conscious. If we do encounter a lack of cooperation or a misunderstanding between the medical and safety departments we try to get to the bottom of the difficulty, and make tactful suggestions to correct the situation. Our entire organization for the control of health and safety works on the basis of getting the job done correctly and quickly without being too much concerned about

who does it. When someone starts doing your job it may be time to sit up and take notice, but if he is doing it better than you are, it may also be preferable to encourage him and study his methods. If he isn't doing a good job, it's time to tell him so.

Being located in the Research Laboratories Division, we are fortunately situated in respect to analytical equipment because if we want to have analytical work done with the spectrograph, x-ray diffraction camera, infra-red spectrophotometer, electron microscope, or other intricate physical instruments, we have only to go down the hall or up a flight of stairs and turn the sample over to an analyst expertly qualified to operate the instrument in question.

All routine industrial hygiene analytical work, however, is done by our own staff. This includes visible and ultraviolet spectrophotometric measurements, the fractionation and identification of solvents, and petrographic examinations of dusts for silica.

That about covers what we *are* doing. Now, in regard to what we hope or expect to do. First, so far as the future of the Research Laboratories Division is concerned we are planning a new, completely modern, air-conditioned building to be built just outside of Detroit to the northeast. This will be a part of the new General Motors Technical Center and is planned as somewhat of a show place. Mr. Kettering doesn't object to impressive looking buildings at all, but he primarily wants something to work in and is holding out for having all the utility built into his Laboratories that engineering research has resolved to date. One of the most difficult hurdles has been to get architects and contractors sold or educated to the point where they are willing to break away from established textbook practices, but progress is being made. When this building is completed our department will have about 5,000 square feet of floor space and plenty of room for expansion if we need it. We plan to do research into the evaluation of the environment, the control of the environment, and the effects of the environment. Our plans for research into the effects of the environment, further than field studies, have reached only a nebulous stage of discussion as to whether we want to enter into animal experimentation and other forms of fundamental laboratory research in this field. To date we have not reached a definite conclusion.

Our plans for industrial hygiene in the Divisions include a full-time industrial hygienist for each plant having serious or numerous potentially harmful exposures; and for plants with lesser exposures, chemists or engineers with industrial hygiene interest and ability who can do certain periodic testing to supplement visits made by our Central Office staff, while devoting the remainder of their time to other technical problems.

In regard to a program for the small plant, it is still all too frequent that industrial hygiene is a matter of telling management what the mistakes have been, and how many tremendously expensive changes will have to be made, rather than getting these ideas into design where the most good will be accomplished easily and more cheaply. Up until the time that our engineering schools take up the teaching of some of the fundamentals of industrial hygiene, the burden of this job will have to rest with the hygienist. This applies to plant design, machine design, and plant layout. Architects are among those who are most in need of instruction in this field.

We have some of the cleanest work places in the world here in the United States and some we don't care to talk about. These latter are the ones upon which we should focus our attention. Independent small plants must depend upon outside sources for their industrial hygiene service, sources such as official bureaus of industrial hygiene in state and municipal health departments, independent consultants, or compensation insurance carriers. In many instances the small plant does not have the benefit of either a competent safety engineer or a process-conscious physician. It is important that the plant physicians have the benefit of all information developed by a survey, but if he is a part-time man he is not likely to be versed on plant processes or much interested in engineering controls. He is likely to be more interested in caring for the waiting patients and getting back to his own private practice. This is the kind of plant where local health departments can be very helpful to both management and employees because without industrial hygiene surveys many exposures in

the small plants are never recognized until someone has been seriously injured. In order to get the best results and a high percentage of implementation of proposed engineering controls, these controls must be discussed with the manager or an engineer and sold by someone who can talk an engineer's language and who yet appreciates the hygiene problems involved. A working arrangement with the purchasing agent or someone who can scan the purchases and allotments of potentially harmful or hazardous materials is a keystone to any continuously successful industrial hygiene program.

In closing I should like to point out some current questions that merit our careful thought. A successful business man recently said to me, "Just what is industrial hygiene? I think you fellows either ought to change the name of your profession or educate the public to an understanding of what you are talking about." What is the best way for us to go about doing this? What measures should we take to advance the recognition of industrial hygiene as a profession? What should be the qualifications of an industrial hygienist and of other industrial hygiene personnel?

Suppose a graduate chemist, for instance, takes up analytical chemistry in an industrial hygiene laboratory—it seems logical to call him an industrial hygiene chemist. If he begins to do more extensive work, such as recognizing and evaluating exposures, possibly he should be called a chemist industrial hygienist rather than an industrial hygiene engineer, which he may not be. Suppose that later he becomes sufficiently proficient in the field of mechanical engineering and ventilation to develop specifications and recommendations for process ventilation—then what are we going to call him? Certainly not a chemist-engineer industrial hygienist or chemist industrial hygiene engineer. Possibly we should reserve the title "industrial hygienist" for persons who are qualified to do all jobs in the field and use the added qualifying term, chemist, engineer, physicist, toxicologist, nurse, physician, and so forth, to indicate industrial hygiene specialists and others who are more intimately concerned with, interested in, or trained in a profession other than industrial hygiene. It would surely be desirable to arrive at some generally acceptable terminology. We are all aware of the confusion which exists; I believe we who are in this work should tackle the problem—possibly through the AMERICAN INDUSTRIAL HYGIENE ASSOCIATION.

A more difficult and more important question to be answered is, "Where is industrial hygiene to be taught—in medical schools, engineering schools, colleges, or trade schools? What subjects should be taught, and what are the prerequisites? What experience or training should be required before a graduate of any such school is permitted to 'practice'?" These are some of the questions that are being asked and all of us should consider them well and try to answer them correctly.

Personnel Placement Bureau

THE COMMITTEE on Personnel Placement of the AMERICAN INDUSTRIAL HYGIENE ASSOCIATION has set up a bureau to facilitate the bringing together of qualified personnel and suitable positions in the several phases of industrial hygiene. This Committee is headed by FRED R. INGRAM of the University of Colorado. This Committee is functioning to serve as an over-all clearing house for industrial hygiene personnel in the catagories of engineers, physicians, technicians, chemists, and nurses. Information on nurses is referred to the American Association of Industrial Nurses, Inc. Industry is requested to register their needs for industrial hygiene personnel and qualified persons their desires for positions with the Committee. While the Committee is not attempting to act as an employment agency, a preliminary screening is undertaken to pair qualifications with requirements. The Committee is pledged to maintain such confidences as are appropriate to this activity and to follow specific requests in this regard. Most of the requests for personnel have so far been from state or other official agency, whereas most of the requests for positions have been for industrial contacts. It is consequently urged that industrial concerns be more generally informed of this service and that they avail themselves of it to a greater extent. Correspondence relative to positions available or persons desirous of making contacts should be directed to MR. FRED R. INGRAM, Chairman, Personnel Placement Bureau, AMERICAN INDUSTRIAL HYGIENE ASSOCIATION, 4200 East 9th Avenue, Denver, Colorado.

The Dispersal and Control of Triethylene Glycol Vapor for Aerial Disinfection

THEODORE T. PUCK, PH.D.,
From the Department of Medicine, the Douglas Smith Foundation for Medical Research and the Bartlett Memorial Fund of the University of Chicago and The Commission on Air-Borne Infections, Army Epidemiological Board, Preventive Medicine Service, Office of the Surgeon General, U. S. Army, and
A. L. CHANEY, PH.D.,
Consultant, Lockheed Aircraft Corporation, Burbank, California

DEMONSTRATION of the powerful killing action of triethylene glycol vapor on air-borne bacteria and viruses, both in the laboratory[1] and in hospital wards,[2, 3] has stimulated interest in the practical application of chemical disinfection of the air. Since air-borne pathogenic agents can be killed by as little as three micrograms of triethylene glycol per liter of air, its use would seem to offer considerable promise as a practical means of preventing the spread of air-borne disease. A number of glycol vaporizers designed to furnish sufficient vapor for continuous treatment of the air of inhabited rooms are now available.[4, 5, 6] However, satisfactory installation of such vaporizers requires careful analysis of the atmospheric dynamics of the spaces which are to be treated.

The two chief problems of such practical application involve the attainment of a uniform distribution and satisfactory control of the concentration of the vapor in the atmosphere.

If the maximum degree of protection against infection is to be secured, a bactericidal concentration of the vapor should be maintained in all parts of the treated space at all times. Achievement of this condition presents certain problems because of the extremely low volatility of triethylene glycol. Thus, the rate of diffusion of a vapor depends upon its pressure gradient. Since the vapor pressure of triethylene glycol is only 0.001 mm Hg at 25° C,[7] the effect of diffusion in dispersing the vapor is negligible. Hence, it is necessary to depend upon the movement of a carrier air stream to secure a uniform distribution. Similarly this low volatility makes the control of concentration more exacting because of the very small margin which exists between a concentration so low that the vapor is ineffective and one so great as to produce supersaturation and fogging of the atmosphere.

Distribution of the Vapor

THE DISTRIBUTION problem is relatively simple where glycol is introduced into a single moderate sized room (i.e. not exceeding about 25,000 cubic feet in volume). A homogeneous dispersal may be achieved by placing the vaporizer in one corner of the room, with an electric fan close by. The fan should be directed at an angle above horizontal so that the air stream strikes the ceiling at a point near the center of the room (Fig. 1). This arrangement permits the use of sufficiently high rates of air motion to obtain good mixing, but since the greatest agitation occurs in the space above head level, uncomfortable drafts are not produced. If the room is particularly long, a second fan also directed toward the ceiling may be stationed in the middle or at

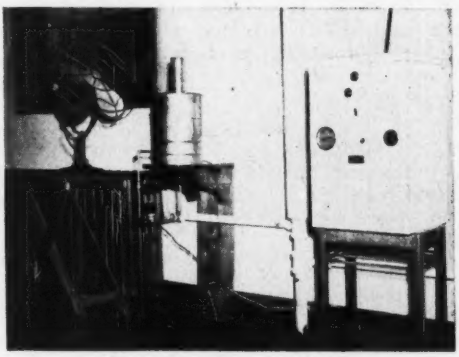


Fig. 1.
Arrangement of fan and gycol vaporizer for distributing the vapors in a hospital ward of approximately 12,000 cubic feet in volume (2). A steam humidifier was placed between the fan and the vaporizer to maintain a relative humidity of about 40%

the opposite end of the room. The two fans should be arranged so that a continuous circuit of the air in the room is produced. (Fig. 2.)

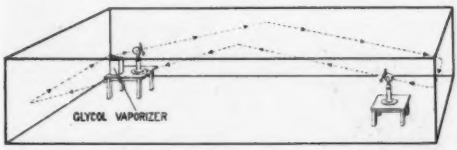


Fig. 2.
An arrangement for providing adequate distribution of glycol vapor in a large room, by means of a single vaporizer and two fans

The situation is more complex when glycol is to be vaporized into a central air circulating system which supplies several different areas. The amount of glycol supplied to each inhabited space must be adequate for its needs, and precipitation of liquid glycol within the duct system should be avoided.

The position at which the vaporizer is installed in a duct system must be selected with some care. The glycol should be injected at a point where the air stream is rapid and turbulent, so that immediate dilution of the vapor occurs. Otherwise, local condensation and precipitation of the vapor may take place in a pocket. It is desirable, too, that the distance traversed by the vapor before entering the rooms be as short as possible, and it is necessary that at no point in its path does the vapor come in contact with any cold surfaces, on which precipitation may occur. The introduction of the glycol vapor should also occur at a point beyond any filters in the air stream since most types of filters absorb the vapor.

Glycol vapor within an inhabited room is removed from the air by adsorption on surfaces, by leakage to the outside and by the respiratory activity of the inhabitants. It is necessary, therefore, that the duct system furnish a sufficient supply of glycol vapor to compensate for all these losses. This means that the air in the delivery duct must transport enough glycol so that after it is discharged and diluted in the room the resulting concentration of glycol is still great enough for effective bactericidal action. The relative glycol concentrations which will be set up in the various parts of the system are schematically indicated in Fig. 3.

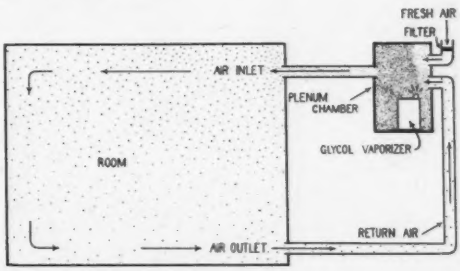


Fig. 3.
Schematic representation of the concentration gradients which are established when glycol vapor is introduced into the conventional type of air-conditioning system. The highest concentration of glycol vapor occurs in the plenum chamber where the vaporizer is located. The concentration in the delivery duct is only slightly less, but that inside the room is materially reduced because most of the losses occur there. If temperatures significantly lower than that of the room occur between the vaporizer and the air inlet liquid glycol will condense and prevent attainment of bactericidal concentrations within the room

It has been our experience with air conditioning systems furnishing about two air changes per hour, that it is necessary to maintain the glycol concentration within the duct at a value at least two or three times as great as that which is desired in the air of the inhabited rooms. The minimum concentration of glycol vapor necessary for bactericidal action under practical conditions has not as yet been determined, but there is reason to believe that it will lie in the vicinity of 60% of the saturation value.[8] Hence, the air in the duct must have a higher capacity for glycol vapor than that in the room, if it is to transport the required amount of glycol without precipitation.

The glycol capacity of an air stream can be increased by raising its temperature. For this reason, the ducts of ordinary air conditioning systems are suitable for the transport of glycol vapor only when the heating system is in operation so that the air temperature in the duct is higher than that of the room. In warm weather, when the duct air is used for cooling, and its temperature is below that of the treated space, its glycol-carrying capacity may be

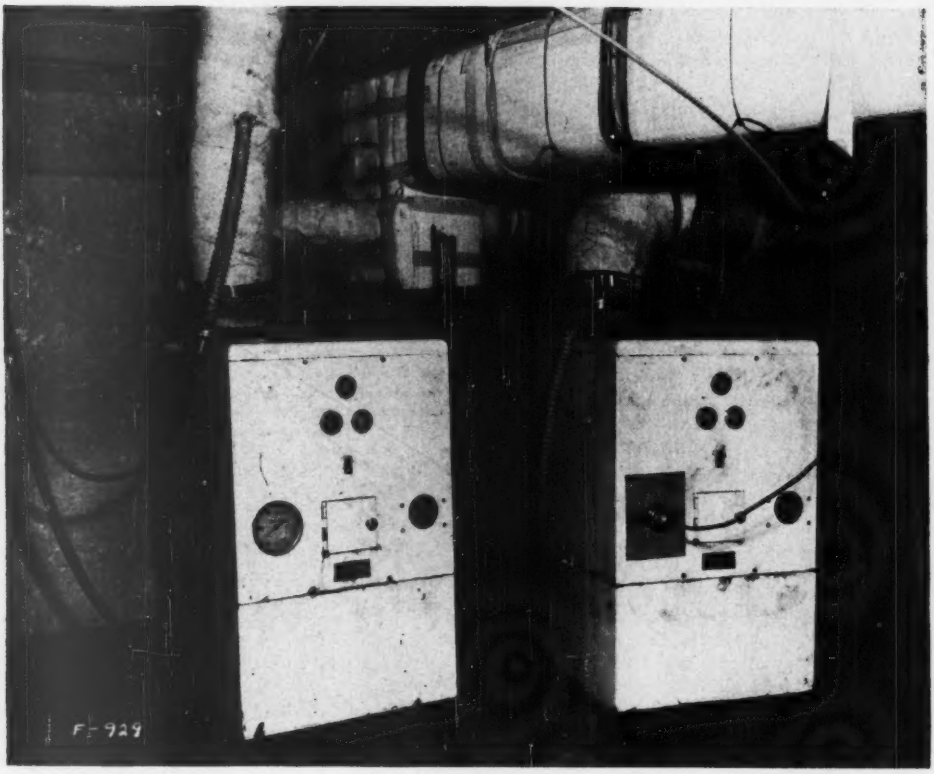


Fig. 4.
Installation of glycol vaporizers in hot plenum chamber of an air conditioning system. Auxiliary heating of the glycol-laden air is provided to prevent condensation at the exit of the vaporizer

reduced so far that only a small fraction of the required concentration can be supplied to the rooms. Hence, if it is desired to use glycol aerial disinfection in the conventional types of air conditioning systems during the summer tme, it may be necessary to provide a separate duct system for the glycol vapor, or to install individual vaporizers in each of the rooms of the system.

Difficulty of this type was encountered in an actual experimental installation where glycol vaporizers were installed in the plenum chamber of an existing air conditioning system.[9] (Fig. 4.) It was found that a certain degree of supersaturation could be tolerated within the ducts without excessive precipitation. However, when the temperature of the duct air fell below 60° F, most of the glycol condensed out on the walls of the duct. Hence, a thermostatic control was arranged which reduced the glycol output of the vaporizer whenever the duct temperature dropped below 60° F. In this way precipitation was eliminated but the problem of providing a satisfactory concentration of glycol during warm weather was not solved.*

The amount of glycol which can be transported in the supersaturated state as an aerosol will be greatest when the duct system has a large cross-sectional area, a rapid air velocity, and a minimum number of sharp changes in direction.

*Since the heaviest incidence of respiratory disease usually occurs in the winter and early spring, it may be advisable to treat the air with glycol only during these months. In that case, the conventional type of air conditioning system may serve very well.

We have found it necessary to test the air currents set up by air conditioning systems in order to ensure that there is no stratification of the glycol vapor, and that all parts of the room are receiving an adequate supply. In one installation, for example, it was found that the air stream travelled directly from the inlet duct to the exhaust without mixing with the air of the rest of the room. Thus, almost half the room was receiving practically no glycol. Where this condition exists it can be remedied by adjustment of the grilles on the air inlets or by provision of baffles at various points in the path of the air stream.

Regulation of the Vapor Concentration

THE BACTERICIDAL action of glycol vapor is determined not by its absolute concentration but by its percentage saturation in the air. The percentage saturation of glycol vapor depends on the relative humidity as well as on the temperature because glycol and water form a two-component system which is completely miscible in the liquid phase.[10] Thus, although the amount of glycol vapor required to saturate the air increases with rising temperature, it decreases sharply with rising relative humidity as shown in Fig. 5. Therefore, any variation in either the temperature or relative humidity of the treated spaces may necessitate a change in the rate at which glycol vapor is supplied by the vaporizer. The rate of vaporization also requires readjustment if there is any change in the volume of fresh air which is being introduced into the conditioning system, or if there is a significant alteration in any of the factors which control the rate of dissipation of glycol vapor inside the treated space.

If, in any installation, all these conditions remain reasonably constant, the necessity for regulation disappears. This situation will occasionally occur in systems where precise control of atmospheric conditions obtains at all times. Most of our experience, however, both in air conditioned spaces and in those utilizing natural ventilation, has indicated that these conditions ordinarily vary to such an extent that frequent adjustment of the glycol vaporizers is required.

Where a single room is supplied with a vaporizer, manual adjustment is feasible

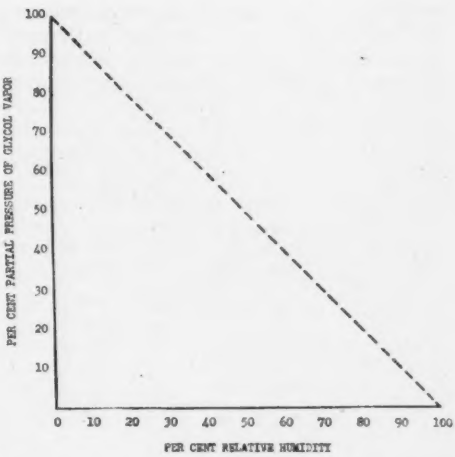


Fig. 5.
Maximum glycol concentration capable of existence in the vapor state, as a function of the relative humidity. These values were obtained by Raoult's Law calculations

but somewhat troublesome, and hence it is likely to be neglected. For a large air conditioned system, it is possible to regulate the vaporizer output to compensate for changes in temperature, humidity, and the volume of fresh air introduced.[15] Such regulation could be made automatic by provision of a mechanism whereby any change in the setting of the fresh-air-intake dampers, or of the temperature and humidity of the ducts, would automatically result in an adjustment of the rate of glycol vaporization. Such a control system would involve coordination of the vaporizer response with the simultaneous readings of a thermostat, a humidistat, and a flowmeter.

Another possibility for control of the glycol concentration in the air is provided by a new instrument, called a glycostat.[11] This device measures the concentration of glycol vapor and can be used to control a vaporizer so as to maintain automatically any desired concentration of glycol in the air. Since it responds to the actual glycol concentration in the air of the inhabited space, the glycostat offers a more direct means of controlling the concentration of the vapor.

The principle of operation is illustrated in Fig. 6. A metal disc whose rim is highly

polished, rotates very slowly with its lower portion immersed in a constant-level water bath. A cloth wick is tightly attached to each face of the disc, and these wicks take

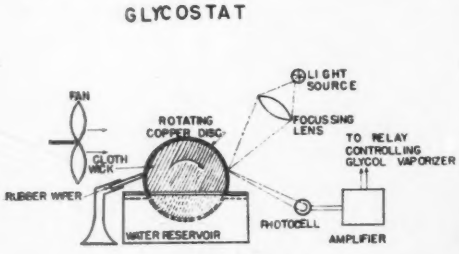


Fig. 6.
Schematic diagram illustrating principle of operation of the glycostat

up water from the reservoir below. The wheel is cooled by rapid evaporation of water from the wet wicks, brought about by a current of air from a small blower. A light beam is focused onto the polished rim of the disc, and reflected therefrom into a photocell. Glycol vapor, when present in the air, condenses on the rim of the cooled disc and, by interference and scattering, diminishes the intensity of light reflected into the photocell. The greater the concentration of glycol in the air, the heavier is the condensate deposited on the wheel and the smaller is the amount of light which reaches the photocell. The photoelectric current can be amplified and made to operate a relay which will control the glycol vaporizer, so that any desired glycol vapor concentration may be maintained in the air.

The portion of the wheel emerging from the water is wiped clean by a piece of neoprene rubber which presses against the rim. Thus a clean area for glycol condensation is always available. This condensation process cannot be interfered with by precipitation of water vapor from the air because the lowest temperature attained by the disc is that of the wet bulb which always lies above the dew point temperature.

This instrument can be set anywhere in the treated space, and will control the output of a vaporizer just as a humidistat controls the output of a humidifier in order to maintain any required relative humidity. The glycostat is sensitive to as little as 0.2 micrograms of triethylene glycol vapor per liter of air. Moreover, an extremely important feature of its operation is that it automatically compensates for changes in temperature and relative humidity. The instrument actually responds to the degree of saturation of glycol vapor in the air. Thus it will maintain any glycol concentration below the fog level regardless of changes in either the temperature or relative humidity. Fig. 7 presents a photograph of the instrument together with a vaporizer and a calibrated meter which continuously records the glycol concentration within a

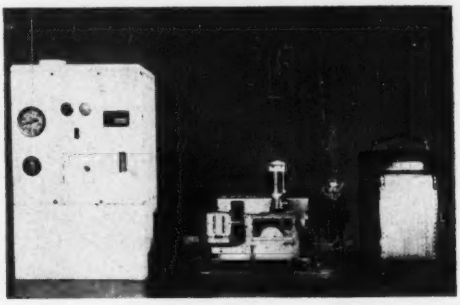


Fig. 7.
Laboratory model of the glycostat (center). On the left is a glycol vaporizer, and on the right is a recording milliameter, whose readings can be translated directly into per cent saturation of glycol vapor

room. In Fig. 8 is shown a calibration curve which was determined by admitting to the

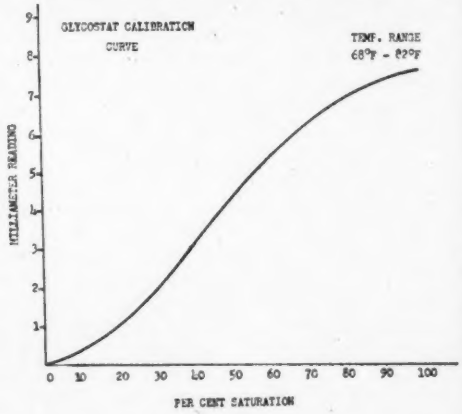


Fig. 8.
Calibration curve for the glycostat, showing the change in the photocell-amplifier output (in milliamperes) as a function of the per cent saturation of air by triethylene glycol vapor

glycostat atmospheres containing known amounts of both glycol and water vapor. This single curve was found to be valid within ±5% over a temperature range of 66 to 85° F, and over a humidity range of 25 to 65% at each temperature.

Fig. 9 shows a typical record indicating how the percentage glycol saturation in the

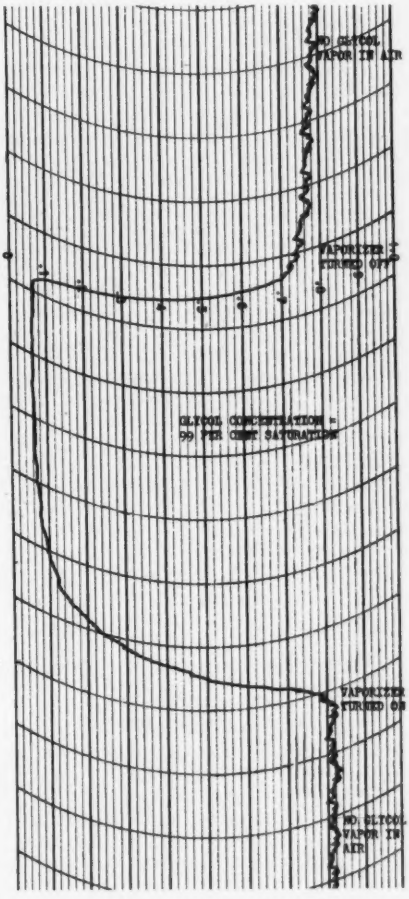


Fig. 9.
Typical record of glycol concentration maintained within a room by means of a glycostat and vaporizer

air was regulated by a glycostat. In order to obtain the most constant glycol concentrations, the vaporizer should be capable of operating at two or more different rates, and it should be possible to change quickly from one rate of vaporization to another. Such an arrangement permits the glycostat to exercise a modulating control which responds quickly to any change in the vapor demands of the treated space, and so reduces to a minimum the fluctuations in the vapor concentration.

The glycostat is still in the laboratory stage of development, and requires further design and engineering to make it sufficiently simple and economical for widespread routine application.*

It may be well to point out one limitation on the action of glycol vapor in practical situations. In the laboratory, under certain carefully controlled experimental conditions, glycol vapor was found to kill *all* the microorganisms present in the air. However, it has not been possible to produce complete sterilization of the air in inhabited rooms. Treatment of such spaces with glycol vapor markedly reduces the number of certain air-borne pathogenic agents such as the hemolytic streptococcus and also produces a significant though somewhat smaller decrease in the number of non-pathogenic bacteria.[2] The maximum reduction in the number of air-borne microorganisms is obtained when the action of glycol vapor is supplemented by dust-suppressive measures.[3]

It is not yet known how low the level of air-borne pathogens must be kept in order that infection be prevented. The few studies of the effect of glycol vapors on the incidence of acute respiratory disease which have been thus far carried out would suggest that glycol vapor exerts a significant prophylactic action.[12, 13, 14, 15] However many additional carefully controlled studies are necessary before an accurate assessment of the usefulness of this technique is possible.

This discussion should serve to demonstrate that, although glycol vapor offers promise in the prevention of air-borne infections, many problems will require solution before its use may be advocated in routine practice. Careful epidemiological investigations must be conducted in order to answer three fundamental questions. These are (a) to what extent can the spread of disease under actual living conditions be

*The Republic Flow Meters Company of Chicago has undertaken to redesign and manufacture the instrument.

prevented by this method; (b) what concentrations of glycol vapor are required for effective action in various types of practical situations, and how closely must these concentrations be maintained; and (c) what influence will be exerted on this prophylactic action by the temperature, the humidity, and the amount of dust in the air. The solution of these problems will require the combined efforts of epidemiologists and ventilation engineers.

Summary

PRACTICAL application of glycol vapors in an attempt to prevent the spread of airborne infection requires a method of uniformly distributing the vapor throughout the treated space and a means of regulating its concentration so as to produce bactericidal action without fogging of the atmosphere. For single rooms of moderate size, adequate distribution can be attained by proper placement of fans. However, where a central air conditioning system is used for dispersal of the vapor, an aerodynamic analysis of the system is required to ensure that each space can obtain a supply of glycol adequate for its needs, and that precipitation of liquid glycol within the duct will not occur.

Regulation of the rate of vaporization so as to maintain a satisfactory concentration is required in any installation where changes may occur in the temperature, the relative humidity, the volume of fresh air introduced into the system, or in the rate of dissipation of glycol vapor from the air of the treated space. A system could be devised which would automatically adjust the vaporizer delivery to compensate for any such changes. A more direct type of control can be accomplished by means of the glycostat, an instrument which automatically measures and controls the concentration of glycol vapor in the air.

Further research, both epidemiological and engineering in nature, is required in order to evaluate accurately the usefulness of glycol vapors in preventing infection.

1. ROBERTSON, O. H., PUCK, T.T., LEMON, H.M., and LOOSLI, C. G. *Science*, 97:142, 1943.
2. HAMBURGER, M., PUCK, T. T., and ROBERTSON, O. H. *J. of Infectious Diseases*, 76:208, 1945.
3. PUCK, T. T., HAMBURGER, M., JR., ROBERTSON, O. H., and HURST, V. *J. of Infectious Diseases*, 76:216, 1945.
4. COEY, S. C, and SPIŠELMAN, J. To be published.
5. BIGG, E., and JENNINGS, B. H. *J. of Indust. Hygiene & Toxicol.*, 26:307, 1944.
6. STOKES, J., *et al.* Unpublished data.
7. PUCK, T. T., and WISE, H. *J. of Physical Chemistry*, 50:329, 1946.
8. ROBERTSON, O. H., *et al.* To be published.
9. POOLE, F. E., et al. To be published.
10. PUCK, T. T., ROBERTSON, O. H., and LEMON, H. M. *J. of Experimental Med.*, 78:387, 1943.
11. PUCK, T. T., WISE, H., and ROBERTSON, O. H. *J. of Experimental Med.*, 80:377, 1944.
12. HARRIS, T. N., and STOKES, J. *Am. J. of Med. Sciences*, 204:430, 1942.
13. HARRIS, T. N., and STOKES, J. *Am. J. of Med. Sciences*, 206:631, 1943.
14. HARRIS, T. N., and STOKES, J. *Am. J. of Med. Sciences*, 209:152, 1945.
15. BIGG, E., OLSON, F. C. W., and JENNINGS, B. H. *Am. J. of Public Health*, 35:788, 1945.

Industrial Hygiene Foundation of America

—Annual Meeting, November 6-8, 1946—

REPRESENTATIVES of member companies of the Industrial Hygiene Foundation will find an increasing scope of industrial hygiene matters covered in the informal, round-table conferences of the day before and the day after the November 7 Annual Meeting of the Foundation. These conferences, to be held at Mellon Institute, Pittsburgh, include a Medical Conference on the morning and a Medico-Legal Conference on the afternoon of that day. A full day's Engineering Conference is also scheduled for November 6, following generally the lines of last year's round-table which was received so enthusiastically by those attending. On November 8, a full day's session is to be devoted to the Chemical and Toxicological Conference.

Manufacturing Chemists' Association

—Safety Data Sheet on Phenol—

CHEMICAL Safety Data Sheets have been released by the Manufacturing Chemists' Association, 608 Woodward Building, Washington 5, D. C., during the current year on formaldehyde, benzene, carbon tetrachloride and phenol. These are available from the Manufacturing Chemists' Association for 15c, 25c, 20c and 20c, respectively. Following the format of the three data sheets previously prepared, that on phenol presents the physical and chemical properties, hazardous properties, shiping containers and labels, procedures on unloading, storage, handling, waste disposal, and health hazards and their control. The material is authoritative and lucidly set forth. All who handle or have contact with phenol should be provided with this data sheet.

Purchasing Department Opportunity

—In Occupational Disease Prevention—

ANDREW H. PHELPS,
Vice President in Charge of Purchases and Traffic,
Westinghouse Electric Corporation

FOLLOWING the presentation of a paper before the Industrial Hygiene Foundation in Pittsburgh last November on the topic "The Place of the Purchasing Department in Maintaining a Healthful Workplace," the question was raised as to how, without introducing too much of an onus on itself, the Westinghouse Purchasing Department keeps its industrial hygienists informed concerning new materials which may involve a potential health hazard, particularly since we have such a myriad of materials. I replied that we had a check in every department of our plant and that we have these matters so coordinated that anything that involves a health hazard immediately goes to the Medical Department for approval.

I have been asked to elaborate on my reply to this question. Just how *does* an industrial corporation the size of Westinghouse Electric go about the purchase of potentially hazardous materials so that there is practically no possibility of their being purchased or used without a thorough investigation of their effect upon the worker?

It is apparent that in a large company such as ours a close control of all the various raw materials and processes be established, otherwise the situation would soon get out of hand. Such a system of control has two main objectives: First, that of coordinating the material requirements and manufacturing methods used in each of our many plants so that improvements arrived at in one location will be available to all. Second, that of cataloging all of the various materials purchased and used so that a program of standardization and simplification becomes feasible.

Obviously it is not practical to refer to materials on drawings, store-room records, etc., under the suppliers' trade names. One reason this is not practical is that suppliers are constantly changing trade names. Furthermore, quite often the product of two or three or more suppliers is acceptable for a given application and it would not be possible to indicate all of the acceptable trade names or other designations for each drawing item.

Presented before the Industrial Hygiene Session, Midwest Safety Conference, Chicago, May 9, 1946.

Westinghouse System

IN OUR system, we have a series of numbers running from 1 to 25,000 which are available for assignment to the raw materials used throughout the Corporation. In this series of numbers there are two main classifications, namely, those of Purchasing Department Specifications and Material Numbers. In the case of Purchasing Department Specifications, we prepare a specification sheet outlining the quality of the material desired. This includes such items as chemical analysis, physical properties (tensile strength, hardness, etc.) and dimensional tolerances. Copies of these specification sheets are given to our suppliers for their use in manufacturing and inspecting the material made for us. Copies are also distributed internally to our design engineers as well as being utilized for inspection purposes. Along with the specification sheet, and bearing the same number, is a card which lists the approved sources of supply, gives the Purchasing Department the correct method of ordering the material and includes a brief statement as to the characteristics and application of the material. This card is distributed within the organization and is not available to our sources of supply.

In the case of those materials where close quality control is not mandatory, or where we have found by experience that the suppliers' materials are acceptable, we do not issue specification sheets but issue only a Materials Card which is distributed within the organization. This card lists the approved sources of supply and their approved grades, gives information regarding the characteristics of the material and gives sufficient information to the Purchasing Department so that the material is ordered correctly.

These Material Cards as well as the cards of the Purchasing Department Specifications are distributed rather widely within our organization to all persons interested in raw materials. This includes the Purchasing Department, Design Engineering Department, Storerooms, Inspection Department, Safety Department.

Method of Operation

IN ACTUAL operation, the system works as indicated in the following example:

1. The Purchasing Department, Materials Engineering Department or Design Engineering Department learns of a new synthetic varnish which is being manufactured by an outside source of supply. An investigation indicates that this varnish is particularly well suited for treating certain railway coils.

2. When it has been decided that we will purchase, stock and use this varnish in our shop, the Materials or Design Engineering Department requests the Engineering Standards Department to assign a Material or Purchasing Department Specification number to it. At the same time the assignment of the number is requested, the Engineering Standards Department is given the characteristics of the varnish including such pertinent data as flash and fire points, the solvent used in the varnish, the specific gravity, viscosity.

3. The Engineering Standards Department then notifies the Headquarters Medical Department that this varnish will be used and includes, with their notification, complete information as to its properties and make-up.

4. The Industrial Hygiene Section of Headquarters Medical Department reviews these data and sends the Engineering Standards Department a brief statement as to the cautions to be observed in using the material. For example, if the fire and flash points are below certain temperature limits, the material is considered flammable and a suitable reference is made to that characteristic. If the solvent used in the varnish is toxic and, therefore, the vapor from it should not be breathed, this also is included in the caution write-up by the Headquarters Medical Department.

5. These data as received from Headquarters Medical by Engineering Standards Department become a part of the card which they issue covering the varnish. This card being distributed to all of the interested personnel, all persons handling the varnish are informed of the hazardous nature of the materials and can take the necessary precautions.

6. In addition, the Industrial Hygiene Section uses the information and data submitted to them by the Engineering Standards Department as a basis for investigating the shop equipment and work layouts where the materials involved are actually used.

Handling Hazardous Materials

IN ADDITION to the cautions which appear on the Material and Purchasing Department Specification cards, a system has been established for handling the potentially hazardous materials to which reference is made in our Process Specifications. A Process Specification as used in the Corporation is basically a sheet of instructions issued by the Engineering Department to the shop for performing a certain operation. This operation may consist of heat treating steel, impregnating a motor coil with varnish or manufacturing a molded part. Finish specifications including painting, enameling, lacquering and metal plating are considered as forms of process specifications although for convenience they are assigned a series of numbers separate and distinct from the series assigned to Process Specifications.

In the Case of Process Specifications the details of the process are generally worked out on a laboratory scale before the specification is written. When the specification is still in tentative form it is submitted to the Headquarters Medical Department for their review. The Industrial Hygiene Section of the Headquarters Medical Department inserts such references to Safe Practice Data Sheet numbers as are necessary to cover the hazardous materials involved in the process. These Safe Practice Data Sheets are issued by the Headquarters Medical Department of the Corporation and give detailed information regarding the potential hazards involved in handling that particular material, including those pertaining to health, fire or explosion.

When the specification is issued in its final form, it is distributed to all of the interested persons and used as a basis for

establishing the process as a regular procedure in the shop. These specifications are kept in a loose leaf binder along with copies of the Safe Practice Data Sheets so that the data are together and available for ready reference by the persons responsible for the operation of the process. There is, therefore, no excuse for ignoring the safety requirements as given on the data sheets.

Formerly some data regarding hazards and precautionary measures were incorporated in the process specification itself. However, it was found that the use of Safe Practice Data Sheets makes it unnecessary to repeat the same safety precautions in every process specification using a given hazardous material. It is also possible in these Safe Practice Data Sheets to cover in more detail the characteristics of the material and the required safety precautions. We do not have a Safe Practice Data Sheet for every material purchased by the company since a large proportion, such as the copper and steel that we use, do not constitute a hazard in themselves. An employee might drop a steel bar on his foot and thus injure himself, although if he were wearing the prescribed safety shoe such an injury would be minimized. In general, all doubtful materials used by the Company, including all chemicals, solvents, paints and compounds, are subjected to a hazard investigation covering such factors as explosion, fire, toxicity and dust.

Process Specifications

A TYPICAL process specification would cover the operation of cementing felt or asbestos to steel. This specification, our No. 50521-E, (the alphabetical suffix indicating the latest revision) contains a prominent note, "Safety Requirements," as follows: "Some materials used in these operations are hazardous. For safety requirements, see Safe Practice Data Sheets designated as SPDS number S-6 and S-9." Safe Practice Data Sheet S-6 covers in detail the properties of the petroleum solvent, particularly from a hazard standpoint, used to clean the steel surface and the precautions to be observed in such use. Safe Practice Data Sheet S-9 gives similar data regarding the properties of the shellac used as a sticking agent in this process.

The Purchasing Department Specification Card for the solvent contains the following note: "Caution: This is a flammable liquid. Keep sparks and flames away. Do not breathe large quantities of vapor. Avoid excessive or continuous contact with the skin."

The Material Card for the shellac contains the following note: "Caution: This is a flammable liquid. Keep sparks and flames away. Do not breathe large quantities of vapor."

One common breakdown of industrial purchases groups them into three classes: Production Material, Expense Materials, and Production Equipment. In the case of production materials, that is, those actually incorporated into the manufactured product, a concrete example taken from our experience might prove helpful. At one time we manufactured a molding powder which contained lead oxide. Our process called for dry mixing this chemical with boric acid. This mixing process resulted in lead dust in the air which was inhaled by the worker and in addition lead fumes were given off when the mixture was baked, both operations resulting in lead poisoning. When this condition became evident, precautions which eliminated this danger were subsequently developed with respect to the process itself and the equipment. The essential point is that, under our present system, similar occurrences in any new process would be prevented at the beginning of its use rather than after the health of the workers had been adversely affected.

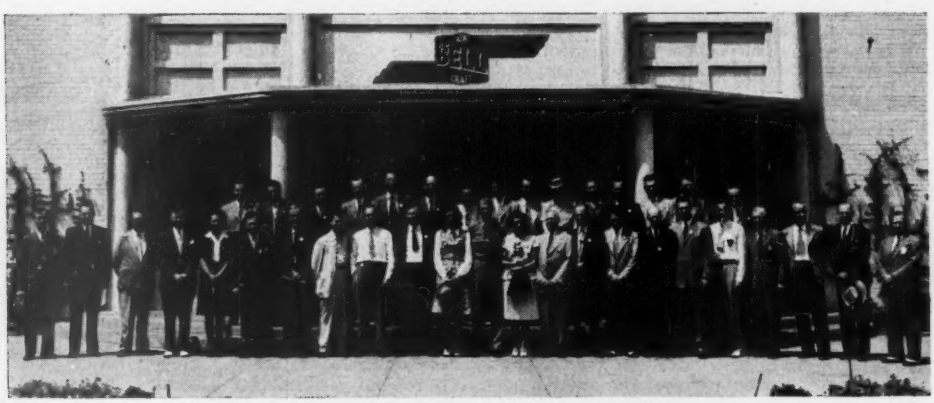
The second class of purchases includes those known as expense or maintenance materials which are consumed during manufacturing operations and are not shipped out of the plant as a physical part of the product. Most of these are controlled by purchasing them according to material numbers. In fact, the Purchasing Department will refuse to buy a material which does not have a number assigned to it for otherwise there is no guarantee that such material has been fully approved with respect to its cost, usefulness, efficiency, or potentially hazardous features. Even such items as goggles, safety shoes and work gloves are assigned material numbers. In these cases, our Safety Supervisor working with our Industrial Hygiene Laboratory will specifically approve such items by supplier and supplier's brand name.

During an emergency it may be necessary to purchase a production material which does not have a material number or specification assigned to it. In such cases, the Purchasing Department is responsible for informing our Safety Engineers of such purchase who then work closely with the Production Department and advise regarding the correct use of these emergency items. I wish to stress, however, that all such cases are eliminated as quickly as possible by assigning material numbers to them, thus bringing them within the system and automatically providing for a checkup on their safe use.

Under the heading of "Production Equipment" could be included x-ray machines for test purposes. A similar hazardous situation exists with respect to the installation and use of all high voltage electrical equipment. It is obvious that these machines create a hazard for those using them as well as other employees located in the same workplace. The specialized nature of such equipment, however, prevents it from being cataloged and classified as is possible when purchasing materials. The only way to avoid possible trouble in this respect is to have all equipment installations checked by a competent safety engineer. Wherever possible, recognized safety standards are utilized by our Safety Organization. Definite procedures for the approval of such equipment are established. In connection with x-ray equipment, the American Standards Association has prepared a safety code, Z-54, which has recently been issued covering precautions to be followed in the use of x-ray machines.

No system is infallible and despite all precautions it is still possible for a material or process to be in use which, unknown to our Industrial Hygiene Section, creates a health hazard for the worker. For that reason, Westinghouse follows the policy of making a periodic physical examination on all workers engaged in hazardous jobs, including those which present the possibility of lead, cadmium, or mercury poisoning. For example, at our East Pittsburgh Works, which employs over 25,000 people, approximately 25% of all production jobs are on this basis. This followup on our use of potentially hazardous materials and processes insures the adequacy of preventive measures which have been taken to protect the health of our workers.

I believe it is apparent that Westinghouse has gone to great lengths to develop an adequate system for checking on the introduction of potentially hazardous materials before they are purchased for general use. While the details of our system as I have given them may not necessarily fit into the method of operations at other plants, it is still clear that unless there is some orderly system of this kind for checking the use of materials from a hazard standpoint, employees are subjected to a number of possible dangers, a risk which is objectionable both from their standpoint as individuals and the possible loss to the concern. Only the best is good enough if it contributes toward the health and safety of the worker.



Members of Georgia Section—American Industrial Hygiene Association

The Use of the Polarograph in the Industrial Hygiene Laboratory

F. H. GOLDMAN,
Sr. Scientist (R), U.S.P.H.S.,
and
IRVING MAY,
Associate Chemist, U.S.P.H.S.

DURING the past few years the field of polarographic analysis has attained such an importance that it deserves the serious consideration of virtually every laboratory engaged in analytical work. Directors of laboratories are finding it necessary to answer the question, "Is it worthwhile to undertake polarographic analysis? Will the results warrant the required expenditure of funds for the necessary equipment?"

Most laboratories which are already employing polarographic methods are convinced that they may be applied advantageously to many industrial hygiene problems. However, there have been instances of laboratories which, after purchasing polarographs, made little or no use of the instrument, or else, experienced disappointment with the results. In all such cases, the fault could be attributed either to the lack of sufficiently well trained personnel capable of operating the instrument and applying it to practical problems, or to failure to comprehend the limitations of the method and its proper place in analytical work.

It would therefore seem desirable to discuss the subject of polarographic analysis from the standpoint of the industrial hygiene chemist.

Historically, polarography is intimately associated with the use of the dropping mercury electrode as the cathode. The anode consists of an electrode with a large surface which is not readily polarized.

The method depends upon the current-voltage relationship obtained when an increasing potential is applied to the electrodes. When the decomposition potential of an electroreducible ion is reached, the current begins to increase rapidly with increasing E.M.F. and then gradually levels off to a limiting value known as the limiting current. The limiting current is caused by an extreme case of concentration polarization at the cathode, and in the presence of a large excess of a non-reducible salt, is produced solely by the diffusion of the electroreducible ions to the cathode. The limiting current is then referred to as a diffusion current. Fig. 1 shows a typical current-voltage curve.

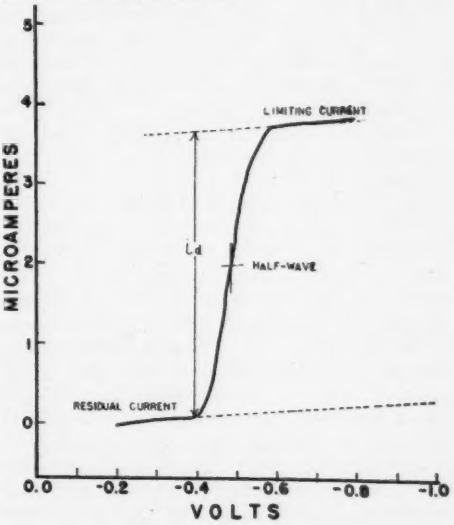


Fig. 1.
A typical current-voltage curve

The magnitude of the diffusion current for a given ionic species is, all other factors being constant, directly proportional to the concentration of the reducible ion. This is the basis for quantitative polarography. The exact equation for the diffusion current has been derived by Ilkovic.[1] It states that

$$i_d = 0.627\ n\ F\ D^{1/2}\ C\ m^{2/3}\ t^{1/6}$$

i_d is the average current during the life of a drop in amperes,
n is the number of electrons involved in the reduction of one molecule of the reducible substance,
F is the faraday in coulombs.
D is the diffusion coefficient ($cm.^2\ sec.^{-1}$) of the reducible substance at a given temperature,

Presented at the April, 1946, meeting of the AMERICAN INDUSTRIAL HYGIENE ASSOCIATION, Chicago.

C is the concentration of the reducible ion in moles per ml.
m is the weight in grams of mercury flowing from the capillary per second,
t is the time in seconds for each drop of mercury.

It can be seen from the above equation that the diffusion current will be influenced by the characteristics of the dropping mercury electrode and the temperature as well as the nature of the reducible ion.

Qualitative polarographic analysis is based upon the fact that the potential at which the diffusion current is obtained is characteristic for a given ion in a particular medium. The potential employed for this purpose is the half-wave potential. It is that potential of the dropping mercury electrode measured against the saturated calomel electrode, at which the measured current is equal to one-half of the diffusion current.

As has been mentioned, the reference electrode must be one which is not readily polarized. Most of the work has been done using a pool of mercury as the reference electrode. This electrode has the disadvantage that its potential varies with the nature of the medium. It also requires the use of large amounts of mercury when many determinations are made. Consequently, it is preferable to use as a reference electrode one which has a known and fixed potential. The saturated calomel electrode is a very satisfactory electrode for this purpose and a suitable one can be readily made in the laboratory. We have been using a compact calomel electrode made by Leeds and Northrup which has proved very satisfactory. We have also employed a silver—silver chloride electrode described by Lingane[2] which consists of a coil of chloride-plated silver wire. This electrode eliminates siphoning difficulties but it cannot be employed in ammoniacal or cyanide media.

Half-wave potentials are usually reported in terms of the saturated calomel electrode. The half-wave potentials obtained with other reference electrodes may be readily converted to standard values by correcting for the difference in potential between the electrode employed and the standard calomel electrode.

Capillaries for the dropping mercury electrode are generally made by drawing out millimeter tubing. Such capillaries, although very useful for micro cells, are quite fragile. Very rugged capillaries can be made from heavy walled capillary tubing with a uniform internal diameter of about 0.05 mm. This tubing can be obtained from the Corning Glass Works.

Elaborate all-glass dropping mercury electrode assemblies are not necessary. We are employing a simple arrangement consisting of a leveling bulb and a heavy walled neoprene tubing. The leveling bulb is supported in the raised position by a Fisher clamp which has a screw arrangement for making fine adjustments of the mercury level. The complete electrode assembly is shown in Fig. 2.

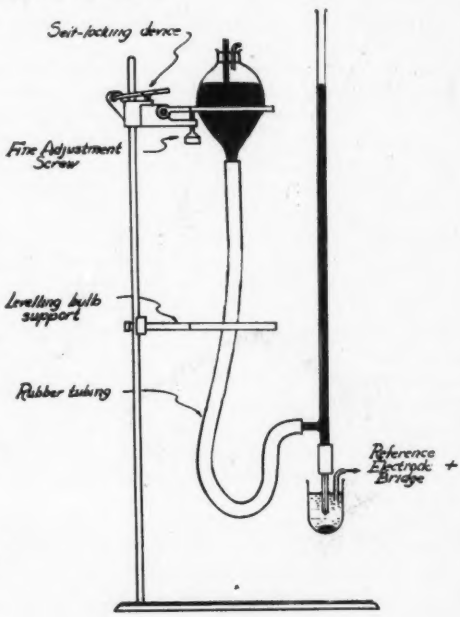


Fig. 2.
A convenient dropping mercury electrode assembly

For routine work, a simple easily cleaned polarizing cell is desirable. Pyrex test tubes of one inch diameter cut down to give cells two inches in height make very convenient cells.

There are a number of commercial instruments available ranging from moderately priced manually operated instruments to expensive automatic recording types. Recording polarographs are time-savers, par-

ticularly when a large number of samples is handled routinely. Those laboratories which anticipate only limited use of a polarograph would do well to purchase a manual instrument.. The possibility of building a polarograph should not be overlooked. Directions for such home-made instruments are in the literature and it should be noted that they can be fully as accurate and sensitive as the best of the commercial instruments.[3, 4]

It cannot be too strongly emphasized that polarographic analysis is not merely a matter of getting the sample into solution, running the instrument for a few minutes, and reading a complete qualitative and quantitative analysis from the curves. It is quite true that routine samples can be handled by relatively untrained technicians *after a satisfactory procedure has been evolved.* However, it is essential that a well trained chemist be available who is capable of maintaining the instrument in working order, devising proper treatment of the samples prior to polarographic analysis, and finally, correctly interpreting the results obtained.

There are a number of factors influencing the diffusion curves that must be controlled. The temperature of the solution must be held constant within $\pm 0.5°$ C. during the analysis. This can be readily done by immersing the cell in a constant temperature water bath.

Inasmuch as the mass flow of mercury affects the diffusion current, the head of mercury in the dropping mercury electrode must also be kept constant.

Dissolved oxygen is reduced over a wide potential range and therefore interferes in most analyses. The interference of oxygen is generally eliminated by bubbling nitrogen or hydrogen through acid solutions, or in the case of alkaline solutions by the addition of sodium sulphite. Although it is a common practice to purify nitrogen before use, it is frequently possible to employ tank nitrogen directly.

In many instances the curves obtained are complicated by the occurrence of maxima which are caused by non-diffusion processes. Instead of the theoretical S-shaped curve, a more or less pronounced peak is obtained in such cases. Fortunately certain surface-active materials such as gelatin when added in small quantities will

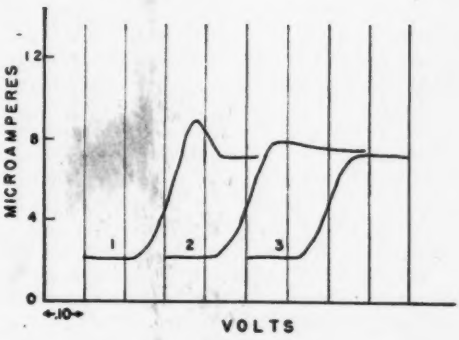


Fig. 3.
Use of gelatin as a maximum suppressor. Curve 1—Zn^{++}(50 micrograms per ml.) in 1:4 ammonium hydroxide. No gelatin present. Curve 2—Same solution as 1 except for gelatin content of 0.005%. Curve 3—Complete suppression of maximum produced by gelatin content of 0.01%

usually suppress these maxima (Fig. 3). It has been recently demonstrated that the occurrence of "well-defined" curves is not in itself a safe criterion of adherence to the Ilkovic equation; but that a sufficient concentration of suppressor must be present so that the slopes of the segments of the curve which precede and follow the wave do not differ by more than a few percent.[5]

The possible occurrence of maxima makes it imperative that when using a manually operated instrument, the analyst should obtain a sufficient number of points on the current-voltage curve to enable him to determine the nature of the curve. If the diffusion current is obtained by measurements at only one or two voltages, the presence of maxima or other irregularities in the curves may remain undetected, thus leading to possibly serious errors in the analysis.

Interferences by other ions is one of the most troublesome difficulties encountered in practice. If two ions have half-wave potentials differing by less than 0.2 volts, their waves will coalesce, making it impossible to measure them accurately. Furthermore, if an ion which discharges before the one being determined, is present in a very much higher concentration, it will be difficult, if not impossible, to make the desired analysis because of the overwhelmingly large current caused by the interfering substance. Inasmuch as the literature

on the subject is still not very extensive, the way in which such difficulties are overcome will frequently depend upon the ingenuity of the chemist. In general, changes of media will often cause changes in half-wave potentials. In many cases the half-wave potential of an ion may be shifted to a marked extent by changing its valence state or by complex-ion formation. Thus, in the determination of lead in air samples, there may frequently be a large amount of iron present. Ferric iron gives a wave at zero applied potential, whereas the half-wave potential for lead is in the vicinity of –0.4 volts. If the sample is first treated with hydroxylamine, the iron is reduced to the ferrous state in which it has a half-wave potential of about –1.5 volts. Therefore, by merely reducing the iron it becomes quite simple to determine minute amounts of lead in the presence of large concentrations of iron without any interference (Fig. 4). When such expedients fail, it becomes necessary to make separations by the use of classical chemical procedures before attempting a polarographic determination.

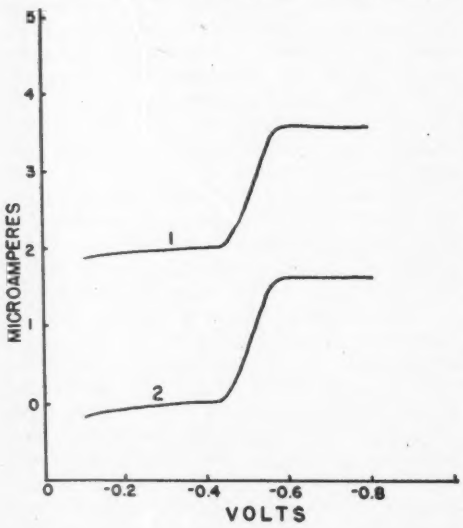


Fig. 4.
Elimination of current due to trivalent iron by reduction with hydroxylamine. Curve 1—Solution contains 40 micrograms per ml. of Pb^{++} and of Fe^{+++} in normal HCl (0.005% gelatin). Note large initial current due to Fe^{+++}. Curve 2—Same solution as 1 treated with hydroxylamine. The current caused by Fe^{+++} has been completely eliminated by reduction to Fe^{++}

It should also be noted that the polarograph may be employed in an amperometric titration which is analogous to conductimetric and potentiometric titrations.[4]

To the industrial hygiene chemist, the polarograph is most useful for the determination of small amounts of the heavy metals. The concentrations in solution which can be handled by the polarographic method range from 0.00001 to 0.01 molar, or, in the case of most metals, from 1-2 micrograms per ml. to 1-2 milligrams per ml. solution. Inasmuch as samples taken in studies of air contamination frequently contain metals in this concentration range, the polarograph, from this standpoint, meets the requirement of the industrial hygiene chemist. In many cases, it is possible to determine two or more metals simultaneously in the same sample with little further effort being required than is necessary for the determination of just one constituent.

The polarograph may also be applied to the determination of some inorganic anions such as the halides by making the dropping mercury electrode the anode instead of the cathode.

The polarographic method is particularly adaptable to the determination of the metallic impurities in a metal when the major constituent is reduced at a more negative potential than are the impurities.

An interesting application is that of checking the purity of precipitates obtained in gravimetric analysis. We recently had occasion to check the possibility of copper contamination in cobalt which had been precipitated by α-nitroso β-naphthol. It was readily demonstrated with the polarograph that copper was absent but it was discovered that minute amounts of molybdenum were present. The presence of the large amounts of cobalt did not interfere with these determinations at all.

A large number of organic compounds, particularly nitrogen and carbonyl compounds have been determined polarographically, although many of the methods are of an empirical nature.

Because of the preliminary work often required to determine the conditions for analyzing a particular type of sample, the polarographic method is of limited useful-

ness to those laboratories whose work consists of analyzing a great variety of samples with rarely more than one or two of a particular kind at a time. Such samples can frequently be handled more expeditiously by the common analytical methods.

There are some cases where the preparation of the sample for polarographic analysis is of such nature that it may be simpler to make the determination by other than polarographic methods. Thus, some procedures for the determination of lead in urine call for ashing of the sample, followed by the isolation and concentration of the lead by electrolysis, or extraction with dithizone prior to polarographic analysis. Such samples could be completed by a dithizone procedure with no sacrifice in time over the polarographic method and probably with greater accuracy and sensitivity.

However, it is not uncommon in industrial hygiene work for a project to be undertaken involving the analysis of dozens and even hundreds of samples, all of a similar composition. Air samples taken in the study of a particular industry or plant are frequently quite similar from a qualitative standpoint. In such cases the time which may be required, if any, for developmental work would be well compensated for by the facility with which the samples could subsequently be handled.

Summary

A BRIEF review has been presented of the principles of polarographic analysis and of the equipment employed.

The polarographic method is particularly applicable to the determination of metals in the concentrations frequently encountered by the industrial hygiene analyst.

Recording polarographs would be of particular value to laboratories routinely handling large numbers of samples of similar composition.

Inexpensive manually-operated instruments may be built or purchased. These would serve the needs of laboratories anticipating occasional use of polarographic methods of analysis.

References

1. ILKOVIC, D.: Polarographic Studies with the Dropping Mercury Cathode. Part XLIV. The Dependence of Limiting Currents on the Diffusion Constant, on the Rate of Dropping and on the Size of Drops. *Collection Czechoslov. Chem. Commun.*, 6: 498 (1934).

2. LINGANE, J. J.: Apparatus for Rapid Polarographic Analysis. *Ind. Eng. Chem., Anal. Ed.*, 16: 329 (1944).

3. LINGANE, J. J., and KOLTHOFF, I. M.: Fundamental Studies with the Dropping Mercury Electrode. I. The Ilkovic Equation of Polarographic Diffusion Currents. *J. Am. Chem. Soc.*, 61: 825 (1939).

4. KOLTHOFF, I. M., and LINGANE, J. J.: Polarography. Interscience Publishers, Inc., New York, N. Y., 1941.

5. BUCKLEY F., and TAYLOR, J. K.: Application of the Ilkovic Equation to Quantitative Polarography. *J. Research Nat'l. Bur. Standards*, 34: 97 (1945).

Exhaust of Vapor from Roller Coating Machines

—As Used in the Can Manufacturing Industry—

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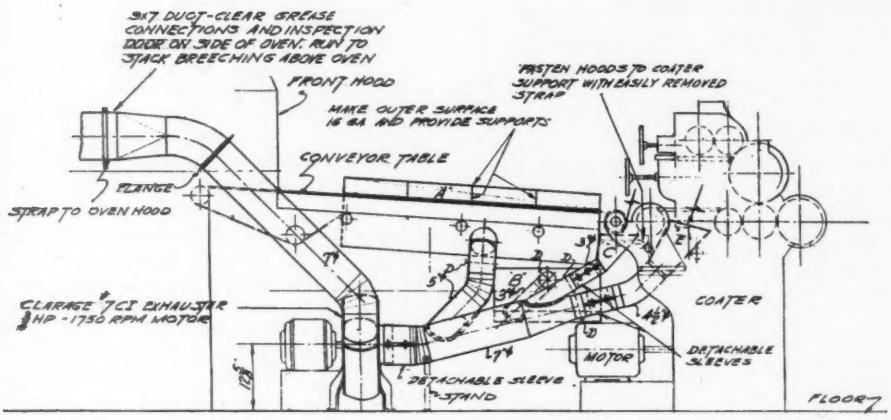
American Can Company

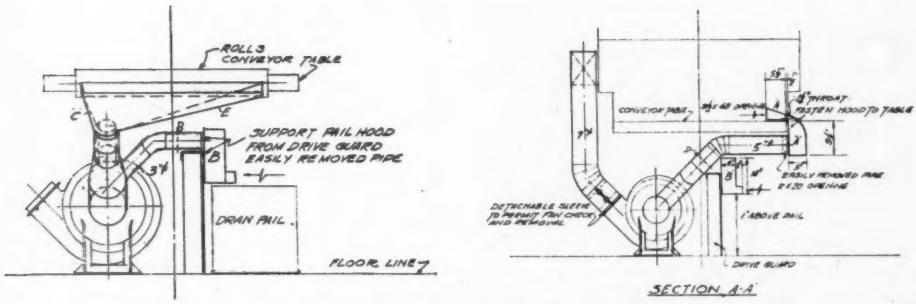
THE APPLICATION of organic coatings to metals used in the fabrication of metal containers is an integral part of the can manufacturing industry. In most instances the process consists of applying a film of enamel or lacquer on metal sheets by means of a roller coating machine prior to cutting the sheets to proper size for forming the cans. The coated sheets are transported by a conveyor belt for the short distance between the coating machine and a ventilated oven where the films are baked at relatively high temperatures. In general practice, neither the coating machines nor conveyor belts are ventilated. This permits odors of solvent vapor to permeate the workroom air. In some instances the odors are of sufficient concentration to be objectionable to workers in the immediate area.

The solvents and thinners used in the organic coating materials are carefully selected. They are relatively innocuous, having vapor pressures such that only comparatively minute amounts of solvents are volatilized prior to the baking operation. As a result of this selection of solvents and

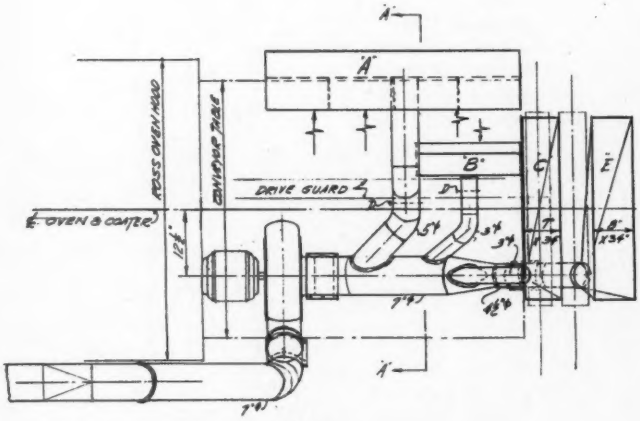
Acknowledgement is made to MR. W. S. BONDY for his part in the design of the system.



Side Elevation



View looking toward oven with hood "A", branch duct, and coater omitted for clarity



Plan View
Exhaust Lay-out of Roller Coating Machine

thinners, concentrations of fumes in the workroom air are well below the accepted safe limits. In spite of this, however, the odor of some solvents near the roller coating machines is usually readily detectable and, in many cases, is unpleasant to employees. From an industrial relations standpoint, therefore, it is often desirable to provide exhaust ventilation for the coating materials.

Several systems have been designed, installed

and tested, and subsequently rejected prior to the development of a satisfactory exhaust ventilation system. Most of these systems have utilized mechanically exhausted canopy type hoods covering the coaters and conveyors. Stationary hoods have been tried where the canopy was fixed several inches above the equipment. Others have been mounted closer to the equipment in such a manner that they could be swung away to permit necessary access to the unit. Other designs equipped with doors and windows enclosing the entire unit from the front of the coater to the oven have been installed and rejected due to interference with operations.

Several objections to canopy type hoods are readily apparent. Operation of coaters requires close observation and inspection of the work. It is frequently necessary to remove sheets from the conveyor belt and subsequently replace them. Minor adjustments are often made on the machine while it is operating. These prerequisites make it imperative that the working space around and over the coater and conveyor belt be kept as free as possible from any devices which might hinder these operations. Coater rolls require frequent cleaning which sometimes makes it necessary for the attendant to have his head above the rolls. Canopy types of hoods, either stationary or movable, are objectionable, therefore, since they interfere with the worker's view and since they afford no protection to the attendant when he is working with his head held over the coater rolls. In the latter instance stationary canopy hoods serve to increase solvent vapor exposures since vapor is drawn upward past his face. Movable canopy hoods, of course, offer no protection whatsoever when it is necessary to move the hood out of the way.

Considering these objections a downdraft system has been designed which eliminates any interference with the workers. The details of the system are shown in the accompanying illustration. It will be noted that local exhaust has been applied at all sources of contamination which can be exhausted without interference to the workers. Four separate exhaust slots are provided. These furnish exhaust at the following sources as shown on the illustration: (A) side of the conveyor table (opposite the working side) which exhausts the coated sheets as they travel from the coater rolls to the oven, (B) coating material reservoir or drain pail, and (C & E) two slots beneath the coater rolls. The total volume of exhaust air is 750 c.f.m. Size of the ducts, which are equipped with dampers, has been adjusted according to the volume of exhaust air required. No more than the optimum amount of air is moved across the rolls or reservoir since too great an air movement would cause undue evaporation at these points necessitating frequent replenishing of thinner. The exhausted air is discharged into the oven ventilation stack. The duct work has been designed to permit convenient dismantling for cleaning. Although the system was designed primarily for the coating of metal plate for cans, it should be readily applicable to similar operations in other industries.

The efficiency of the system has been demonstrated by comparing solvent vapor concentrations in the air of a room with and without operation of the exhaust system. A room was chosen for the tests which contained three coaters all of which were equipped with this type of ventilation. The results of the tests are shown in the accompanying table. It will be noted that an average production of solvent vapor concentrations in the normal breathing zone of about 60% is effected by the coater ventilation. Experience has shown that even greater reductions may be expected where the initial concentrations are higher.

The solvent vapor concentrations in air were determined by scrubbing a measured volume of air in chromic acid contained in sintered glass scrubbing tubes and subsequently measuring the reducing power of the absorbed solvent. The method (*) was specifically calibrated for each solvent and combination of solvents in use. Each value shown in the table represents the average of at least three determinations. Samples were taken at specific locations at various times during the entire day so that any wide fluctuations which might occur as the day progressed would be detected. No significant fluctuation was noted. A total of 36 such determinations were made. Care was taken to maintain all variables except the presence or absence of ventilation as constant as was possible under the condi-

*Details of this special method will be released for publication in the near future.

EFFECTIVENESS OF COATER VENTILATION IN REDUCING SOLVENT VAPOR CONCENTRATIONS IN WORKROOM AIR

Unit Number	Solvent in Coating Material	Average Concentration of Solvent Vapor in Working Area Near Coating Machines (P.P.M. by Volume) Without Ventilation	With Ventilation	Percent Reduction
1	Petroleum Hydrocarbons	54	18	67
2	Ketones	24	12	50
3	Ketones and Aromatic Hydrocarbons	22	6	73
		Average Concentration 10 Inches Above Coated Sheet being Conveyed to Oven*		
2	Ketones	239	45	81
3	Ketones and Aromatic Hydrocarbons	202	9	96

*These samples were taken above the conveyor table on the edge opposite the exhaust slot and, due to the location of the sampler, are not representative of air in the normal breathing zone.

tions of normal commercial production. Identical sampling locations, coating materials, and conditions were employed both with and without the coater ventilation. Comparative tests were carried out in as short a period as possible in order to minimize effect of changing weather and natural ventilation. In addition to tests taken in the breathing zone of the normal working area, determinations were made at certain locations with the sample air intake kept within a few inches of a source or focal point of air contamination. The reduction in extent of contamination brought about by the ventilation system was, of course, more pronounced in these tests.

It is gratifying to note that in addition to the significant effectiveness of the system as shown by tests, the acceptance of the installations by coater operators has been most favorable. This is predicated on the fact that the system aids materially in reduction of solvent odors and that the equipment can be operated with a minimum of interference.

Summary

AN EXHAUST ventilation system is presented for roller coating machines used in the application of enamels and lacquers to metal sheets in the can manufacturing industry. The system is designed with particular emphasis on minimizing inconvenience to machine operators. For this reason the installation does not eliminate all escaping solvent vapor but by applying local exhaust to focal points of air contamination, the concentrations of solvents in air are reduced materially and maintained below a safe level as well as an objectionable level. Favorable employee acceptance is established.

DR. MORRIS B. JACOBS, after terminating his work as Technical Aide in Division 9 (Chemistry) of the National Defense Research Committee of the Office of Scientific Research and Development, resumed his full duties as Senior Chemist in the Department of Health of the City of New York and was designated Chief of the Chemical Laboratory. On May 3, 1946, DR. JACOBS lectured on "Poisons" before the Princeton Section of the American Chemical Society and the Princeton Chemistry Club at Princeton, New Jersey. In the fall semester, 1946, at the Polytechnic Institute of Brooklyn, DR. JACOBS, Adjunct Professor of Chemical Engineering, will give a course on the "Technology and Chemistry of Economic Poisons." This course is designed to cover a wide group of compounds for the control of insect pests, rodents, weeds, bacteria, and molds.

DR. LEONARD J. GOLDWATER, who returned to New York last winter after four and one-half years of active duty as an industrial health officer in the Navy, has been appointed Professor of Industrial Hygiene at the Columbia University School of Public Health, filling the position left vacant by the retirement of DR. FREDERICK B. FLINN. DR. GOLDWATER is one of the founders and has been an active member of the Metropolitan New York Section of the A.I.H.A. He was elected Counselor at a recent meeting. In his work at Columbia, DR. GOLDWATER will have charge of teaching industrial hygiene to the undergraduate medical students at the College of Physicians and Surgeons, as well as the required and elective courses in the School of Public Health, and in addition he plans to carry on a program of industrial hygiene research.

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Industrial Hygiene Development

STRIKING, indeed, has been the introduction of a myriad of new materials and processes throughout industry, but the advent of organized control of health hazards arising from them has been no less so. It was not long since that solvents which found their way into industry in general were largely limited to naphtha and carbon tetrachloride, benzol and carbon disulphide, amyl acetate and denatured alcohol. The naphtha might have been of comparatively innocuous petroleum origin or from more toxic coal-tar sources, and it might have been called benzine with little thought as to whether it was alkyl or aryl in its chemical structure.

As windows and doors were closed to keep out the cold of approaching winter months, solvent vapors were kept in. Resulting complaints caused inspectors to become aware of a possible hazard and, if benzol was being used, an order was issued to substitute the less injurious benzine. In a number of instances the orders were readily followed, as low temperatures caused difficulty through freezing of the benzol in the tank car. But at the end of the winter, benzol was again ordered and all, including the workers, were pleased as it worked so much better than the wide boiling-point-range benzine which didn't smell a bit better and seemed to be just as irritating as the solvent for which it was substituted. That is, everybody was happy except the unfortunate worker who happened to be the most exposed or the most susceptible to the benzol, and he might be feeling very bad with all too good reason.

As the advantages of new materials became apparent and the costs of broadening occupational disease compensation acts increased, more effective methods for making it possible to utilize these materials without the penalties attendant to injuring the workers' health became more urgent. In the early thirties, a German report[1] on metal cleaning with trichlorethylene included reference to some 106 cases of poisoning—to be sure, many of them were only dermatitis though six of the others were fatal—resulted in the order in that country that no open-top vapor degreasers employing trichlorethylene be permitted. A valuable process was thus denied German industry whereas industrial hygiene as developed here has been instrumental in the continued use of open-top vapor degreasers without any appreciable injury to health.

Development of industrial hygiene as we know it in this country today began with the studies of the Office of Industrial Hygiene in the U. S. Public Health Service and became widely applied through the state divisions of industrial hygiene and a number of the insurance companies. A more recent tendency is the institution of industrial hygiene services by industrial concerns themselves.

THE first issue of the Association publication as the AMERICAN INDUSTRIAL HYGIENE ASSOCIATION QUARTERLY carried an account[2] of the industrial hygiene organization of a leading concern operating many plants throughout the country. The interrelation of the industrial hygiene group with the various elements of the concern having special interests in the subject, including manufacturing, industrial relations, insurance, engineering and research, and its operation under a general health committee with the vice-president of manufacture and the vice-president of research and development as co-chairmen is recommended for close study by any concern contemplating the formation of an industrial hygiene unit. This type of organization is particularly well adapted to the coordinated effort of interested departments with close supervision of top management. To be effective, such an industrial hygiene unit must be implemented with well qualified personnel and adequate equipment to carry on the essential technical activities. It may be observed that such is the case in the concern to which this reference is made.

Elsewhere in this issue is a complete description of the industrial hygiene depart-

ment of one of our largest corporations recently developed under the direction of one of the country's leading industrial hygienists; also, an account of the important part the purchasing department plays in control of potential health hazards in another of the great corporations of the country. A complete account of the methods followed by this latter concern appeared in the Association's publication some years ago[3] and proved of tremendous value in successfully handling the greatly accentuated problems over the war years. The papers in this issue to which reference is made speak for themselves as to the competence of the organization which each describes for furthering industrial hygiene within the plants of these concerns.

The individual set-up of every industrial establishment differs from that of others and requires its own type of organization. In order to show what is being done in industrial hygiene by foresighted concerns, the programs of a number of them are to be published in forthcoming issues of the AMERICAN INDUSTRIAL HYGIENE ASSOCIATION QUARTERLY. The development of such organizations within industrial concerns is significant both as evidence of their intelligent concept of methods of assuring healthful working environment while availing themselves of technological advances, and also as evidence that modern methods of industrial hygiene are recognized as integral to sound industrial management. Industrial hygiene development is thus progressing steadily along effective lines. The scientific methods which have accounted for its advances have not sacrificed an essential practicality in recommended improvements. Through its procedures, evaluation of the hazard is transferred from the realm of conjecture to that of comparative certainty; its handling from a matter of judgment to one of directed engineering control.

References

1. STUBER, KATHARINA: Injury to health by industrial utilization of trichlorethylene and the possibility of prevention. *Arch f. Gewerbep. u. Gewerbehyg.*, 2:398-456, 1931.

2. TAYLOR, L. V.: The industrial hygiene organization of the American Can Company. *A.I.H.A. Quart.*, 7:9-13, 1946.

3. BARNES, E. C.: Control of industrial health hazards —Westinghouse Industrial Hygiene Department. INDUSTRIAL MEDICINE, 11:500-504, 1942.

LOOKING toward another valuable program for the next Annual Meeting of the AMERICAN INDUSTRIAL HYGIENE ASSOCIATION, to be held April 27-May 3 at the Hotel Statler, Buffalo, New York, it is requested that members of the Association stimulate the submittal of papers and ideas for scientific exhibits on subjects covering the various phases of industrial hygiene.

Papers on industrial toxicology, engineering control of occupational health hazards, surveys of industrial processes for occupational disease exposures, together with other factors such as industrial fatigue, illumination, noise, are among the subjects pertinent to this meeting.

Titles of papers with a brief description of subject matter should be sent as early as possible to COL. T. F. HATCH, President-Elect of the Association and Chairman of the Program Committee, addressed to him at the Industrial Hygiene Foundation, 4400 Fifth Avenue, Pittsburgh 13, Pennsylvania. Papers are acceptable both from members and non-members of the Association.

THE AMERICAN Standards Association presented Certificates of Appreciation to a number of its committee members who had made substantial contributions to the preparation of War Standards. Receiving this award at the ceremony held on August 14, 1946, at the Officers Club, Brooklyn Navy Yard, were the following members of the American Industrial Hygiene Association: ROY S. BONSIB, A. G. CRANCH, M.D., R. H. FERGUSON, LEONARD GREENBURG, M.D., S. W. GURNEY, R. C. STRATTON, and C. R. WILLIAMS.

THE following promotions have recently been announced among the personnel of the Division of Industrial and Safety Standards, New York State Department of Labor: MR. WILLIAM B. HARRIS, formerly Assistant Industrial Hygiene Engineer, has been promoted to Senior Industrial Hygiene Engineer on his return from the Army, and is now located in our New York Office. MR. ARTHUR E. PERINA, formerly Assistant Industrial Hygiene Engineer has been promoted to Senior Industrial Hygiene Engineer. MR. ROBERT HALPIN, formerly Assistant Industrial Hygiene Engineer, New York Office, has been promoted to Senior Industrial Hygiene Engineer on his return from the Army and temporarily assigned to the Albany office of the Division of Engineering. MR. BEN DOLAN, for the past several years Assistant Chemist, has been promoted to Assistant Industrial Safety Engineer.

American Industrial Hygiene Association

News of the Local Sections

Chicago Section

THE PRESENT officers are: Chairman, H. H. STEINBERG, M.D., International Harvester Company; Vice-Chairman, L. V. TAYLOR, American Can Company; Secretary-Treasurer, H. T. WALWORTH, Lumbermens Mutual Casualty Company; Executive Committee, J. I. BANASH, consulting engineer; HENRY BECKER, Zurich Insurance Company; M. F. BIANCARDI, Allis-Chalmers Manufacturing Company; JOSEPH CHIVERS, M.D., Crane Company; FRED COOK, Bituminous Casualty Company; WARREN A. COOK, Zurich Insurance Company; MILDRED FREY, Western Electric Company; L. E. HAMLIN, M.D., American Brake Shoe Company; GEORGE KNOLL, Mine Safety Appliance Company; K. M. MORSE, Illinois State Health Department; LESLIE STOKES, Illinois State Department of Labor; LOUIS STREB, Charles E. Crone Company; FLOYD VAN ATTA, National Safety Council; R. M. WATROUS, M.D., Abbott Laboratories; CHARLES W. WYMAN, Western Electric Company.

Starting a precedent, the first meeting of the 1946-47 year is to be addressed by the outgoing Chairman. WARREN A. COOK will speak on the subject, "The Outlook for Industrial Hygiene," at the dinner meeting on September 18.

Georgia Section

SECRETARY of the Georgia Section is W. E. MCCORMICK, Division of Industrial Hygiene, Georgia Department of Public Health, 12 Capitol Square, Atlanta.

The Georgia Section of the A.I.H.A. held a meeting at the Atlanta Athletic Club, Friday evening, June 28, 1946, with MR. FRANK A. PATTY, Industrial Hygiene Consultant, General Motors Corporation, Detroit, as guest speaker. Approximately 40 members and guests were present. MR. PATTY spoke on the general organization of an industrial hygiene department in private industry, and discussed in particular that of the General Motors Corporation. His paper apears elsewhere in this issue. Following his talk the film, "Doctors in Industry," was shown by an Atlanta reresentative of the General Motors Corporation. Out-of-state members and guests from Alabama, North Carolina, South Carolina and Tennessee were present. (See page 20.)

Michigan Section

THE SECRETARY of the Michigan Section is A. C. FUNKE, 276 Third Avenue, Detroit 21.

New England Section

THE SECRETARY of the New England Section is LESLIE SILVERMAN, Harvard School of Public Health, 55 Shattuck Street, Boston 15.

Among the A.I.H.A. members participating in the Seventh Annual Congress on Industrial Health being held by the American Medical Society in Boston, September 30-October 2, are PHILIP DRINKER, Harvard School of Public Health, Boston, LAWRENCE T. FAIRHALL, PH.D., Industrial Hygiene Division, U. S. Public Health Service, Washington, D. C., and ROBERT A. KEHOE, M.D., Kettering Laboratory of Applied Physiology, University of Cincinnati Medical School, all of whom are presenting papers before the Conference on Lead Poisoning on September 30. D. B. DILL, PH.D., Fatigue Laboratory, Harvard University, Boston, is presenting a paper in the Symposium on Work Capacity on October 1.

New Jersey Section

THE SECRETARY is W. F. WEBER, 11 LaSalle Street, Cranford, New Jersey.

Metropolitan New York Section

THE SECRETARY is LEOPOLD SCHEFLAN, M.D., P.O. Box F, Clinton Hill Station, Newark, New Jersey.

The first meeting of the 1946-47 season is to be held on September 26, 1946. The program is to be as follows:

Speakers: DR. JOHN H. FOULGER, Director, Haskell Laboratory of Industrial Toxicology, Wilmington, Delaware. Subject: "Differential Heart Sound Meter." DR. LESLIE SILVERMAN, Assistant Professor of Industrial Hygiene, Harvard School of Public Health, Boston. Subject: "Respiratory Air Flow Characteristics."

An afternoon meeting is to be held on October 24, 1946, at 2 P.M. at the American Museum of Natural History, Central Park West at 79th Street, New York City, Room 419, Roosevelt Memorial Building following a pre-meeting luncheon at the Cafeteria Restaurant in the basement of the Museum at 12:30 P.M. The program is to include the following papers: "An Improved Portable Anemometer," WILLIAM B. HARRIS, Industrial Hygiene Engineer, New York State Department of Labor, New York City; "The Use of X-Ray Diffraction for Chemical Analysis," F. G. FIRTH, Industrial Division, North American Phillips Company, Inc., New York City: "Health Hazards in the Use of Beryllium," DR. IRVING

TABERSHAW, Liberty Mutual Insurance Company, New York City; "Use of Electrostatic Precipitation for Industrial Dust Collection," E. H. R. PEGG, Aerotec Company, White Plains, New York; "Estimation of Sulphur Compounds in Air," BENJAMIN FEINER, Industrial Hygiene Engineer, SAMUEL MOSKOWITZ, Chemist, New York State Department of Labor, New York City.

Meeting of December 5, 1946 (Thursday). Annual Meeting: Election of Officers. Subject: "Health Hazards and their Control in the Preparation and Use of Powdered Metals."

North East Ohio Section

H. G. DYKTOR, Bureau of Industrial Hygiene, Division of Health, Cleveland 14.

On August 21, a meeting of the temporary executive and program committees was held to arrange the affairs of this Section for its first year. MR. FREDERICK MALLETTE, Industrial Hygienist and Toxicologist, The Firestone Tire and Rubber Company, is Chairman, *pro tem* and has made plans for the first regular meeting of the Section at the new Research Laboratory of Firestone in Akron for the last of September.

Pittsburgh Section

C. F. MEHAFFEY, Secretary, 201 North Braddock Street, Pittsburgh.

It is anticipated that the Pittsburgh Section will continue its practice of holding a meeting the evening of the Annual Meeting of the Industrial Hygiene Foundation on November 7.

St. Louis Section

ROBERT M. BROWN, Secretary, Room 62, Municipal Court Building, St. Louis 3, Missouri.

Southeastern Section

FOR SOME time there has been a feeling among industrial hygiene personnel of the southeastern states that a Southeastern Section or Conference of the A.I.H.A. would be quite desirable. At the present time, insufficient A.I.H.A. members reside in many of these states to organize separate local sections. Consequently, the organization of a regional section or conference has been undertaken.

Industrial hygiene representatives from both private industry and state groups met at the Georgia State Health Department, Atlanta, for the preliminary organization on June 28, 1946. Personnel from Alabama, Georgia, North Carolina, South Carolina, and Tennessee were in attendance, with MR. FRANK A. PATTY, President of the A.I.H.A., as a guest. A committee, consisting of N. V. HENDRICKS, Chairman, Georgia State Health Department, MR. GILBERT H. DUNSTAN, University of Alabama, MR. JAMES W. HAMMOND, South Carolina State Health Department, and MR. FRANK OGLESBY, Tennessee Eastman Corporation, was appointed to draw up a set of by-laws, nominate officers, and petition the A.I.H.A. for admission as a local section.

One of the primary objectives of this newly organized group is to promote the organization of additional A.I.H.A. local sections in the various southeastern states, as well as to serve as a clearing house for industrial hygiene activities within this area. It is hoped that one or two meetings may be held each year at which time industrial hygiene activities and problems of this area will be discussed.

Washington-Baltimore Section

HARRY E. SEIFERT, Secretary, Division of Industrial Hygiene, National Institute of Health, Bethesda, Maryland.

AT THE time this issue of the Quarterly goes to press, the programs of a number of the local sections had not been received. Notices will be sent to all members of local sections and to other interested persons on request to the secretary of the respective section.

REAR ADMIRAL JOEL T. BOONE, Director of the Medical Survey Group, Coal Mines Administration, has announced the addition to his staff of S. CHARLES ROTHMANN, of Charleston, West Virginia, and New York City, as a consultant in industrial hygiene engineering. ROTHMANN was graduated in 1929 from the University of Pittsburgh with the degree of Bachelor of Science. In 1939 and 1946 respectively he took postgraduate courses in industrial hygiene at the University of Pittsburgh Medical School and at the Long Island College of Medicine, New York City. In 1936-37 he attended seminars at the Harvard School of Public Health. From 1932 to 1935, ROTHMANN was associated with the West Virginia State Health Department, as industrial hygiene and public health engineer, and then as chief industrial hygiene engineer of the West Virginia Compensation Commission. In the military service, ROTHMANN was made commanding officer of the Army's industrial hygiene laboratory at Johns Hopkins University, Baltimore, Maryland. He continued in this work until April, 1943, when he was appointed industrial hygiene engineer of the 2nd Service Command, U. S. Army, in which position he was responsible for safeguarding the health, safety, efficiency and welfare of more than 80,000 war workers in 40 Army-operated establishments.